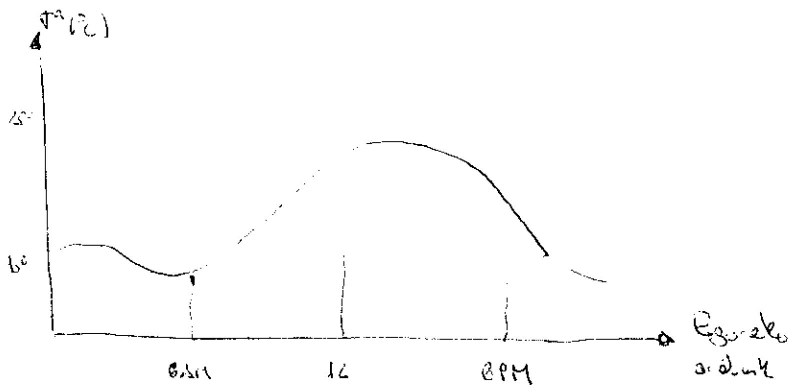
FD-II-002

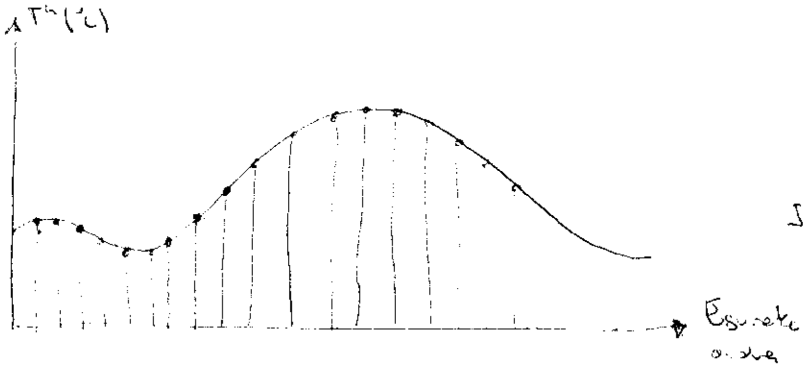
1 Gai Sarrera

1.1 Seinale analogikoak - seinale digitalak
1.2 - Transistoreetatik zirkuitu integratuetararino
1.3 - Zirkuitu digitalak - konbinazionalak / sekuentzialak
1.4 - Zenbakien sistemak
1.5 - Kode bitarrak
1.6 - Kode alfanumerikoa
1.7 - Kode bihurketa
1.8 - Biten eragiketa aritmetikoak
1.9 - Biten eragiketa logikoak



Seinale analogikoa

Infinitu puntu dauzka



Seinale bat digitaltzeko lehenengo pausua

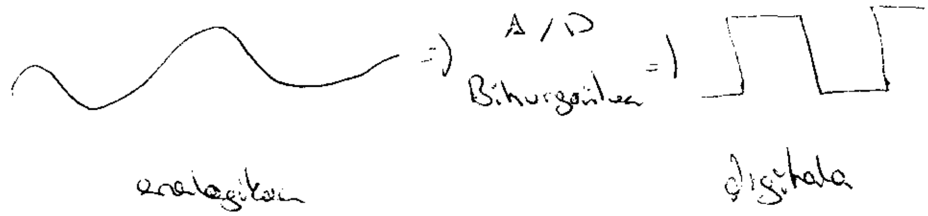
Infinitu beharrean puntu kopuru zehatza izatea.

Logika positiboa { Maila logiko altua (1) → tentsioaren balio altuena
Maila logiko baxua (0) → tentsioaren balio baxuena

Logika negatiboa { (1) → baxuena
(0) → altuena

Abantailak

Fidagarritasuna
Trinkotasuna
Zaratarekiko eguintea



$37/2 = 18 \quad h=1$

$18/2 = 9 \quad h=0$

$9/2 = 4 \quad h=1$

$4/2 = 2 \quad h=0$

$2/2 = 1 \quad h=0$

1

100101

↓ MSB … ↓ LSB

More / Less significant bit

A: ketak

11	100	111	110	11	11	111	110	1110
+ 11	+ 10	+ 11	+ 100	- 01	- 10	- 100	- 101	- 11
110	110	1010	1010	10	01	011	001	1011
3+3=6	4+2=6	7+3=10	6+4=10	3-1=2	3-2=1	7-4=3	6-5=1	14-3=11

11	11	111	1011
x 1	x 11	x 101	x 1001
11	11	111	1011
	11	000	1011
	1001	111	1100011
		100011	
3x1=3	3x3=9	7x5=35	11·9=99

110 | 11
-11 → 10
000

6 / 3 = 2

110 | 10
-10 → 11
010
-10
00

6 / 2 = 3

---

3 → 00000011

-3 → 11111100

1eko osagarria (1ak 0 bihurtu eta 0ak 1 bihurtu)

10110010

pos 01001101 → 1eko osagarria

neg 01001110 → 2ko osagarria

2ko osagarria (LSBari 1 gehitu)

1eko osagarria:

Zenbaki positiboak beti berdin

Zenbaki negatiboak → positiboaren 1eko osagarria

2eko osagarria:

Zenbaki positiboak betikoen 1eko osagarria

Zenbaki negatiboak → positiboak (1eko osagarria) +1 LSBan

BCD Aiken

1eko osagarriak

(0 - 9) < 0000 / 1111

(1 - 8) < 0001 / 1110

(2 - 7) < 0010 / 1101

(3 - 6) < 0011 / 1100

(4 - 5) < 0100 / 1011

0 → 0000	9 → 1111
1 → 0001	8 → 1110
2 → 0010	7 → 1101
3 → 0011	6 → 1100
4 → 0100	5 → 1011

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Autotesta (1 saioa)

1 d) 25
2 a) 13
3 b) 221
4 c) 10001
5. c) 11010111
6. a) 101001
7 d) 100
8. b) 01000110
9 d) 00111000
10 a) 0111010
11 c) 1101110
12. d) -107
13 b) 5471241
14 c) 8D46F
15. a) 1111 0 1111010 1001
16 b) 010001110011
17.
18.
19.
20.

19) a) 00010000   g) 01000100
b) 00010011   h) 01010111
c) 00011000   i) 01101001
d) 00100001   j) 10011000
e) 00100101   k) 000100100101
f) 00110110   l) 000101010110

20) 100|0000 → 40
0010001|0111 → 237
0011|0100|0110 → 346

18) 1010 $\boxed{1100}$ 1100
00010   0067   00011
1100001001|10000C1110

9)
00010011
00110111
1
00111000

10)
111010
$-$000101
1
000110

11) 100010
$-$011101
$+$ 1
110111C

~~1010   00010~~
~~1111   00011~~
~~1111~~
~~1100001001~~
~~1010001001~~

12) 1001011
$-$ 1
10010010
01101101
64 32 8 4 1
96 13 109

13) 10|1100|1110|0|10|1101|0|0|1
5 4 7 1 2 4 1

14) 1|1000|1101|0|110|1111
8 13 4 6 15
8D46F

15) F7A9
$15 \cdot 16^3 + 7 \cdot 16^2 + 10 \cdot 16^1 + 9 \cdot 16^0 = 63401$
1111011110101001

16) 473
0100 0111 0011

17) a) ~~1110~~ 00010100
b) ~~0001 0001 1100~~ 00010010
c) ~~0001 0001~~ 00010111
d) 00010110
e) ~~01000100~~ 0110110
f) ~~10101001~~ 0010110101
g) 100101111 00110000 0011
h) 110001101001 0011000101101011

$$\left(\begin{array}{ll} \begin{array}{r} 00100101 \\ +\ 00100111 \\ \hline 01001100 \end{array} & \begin{array}{r} 01010001 \\ +\ 01010100 \\ \hline 10101001 \end{array} \\ \begin{array}{r} 10001000 \\ +\ 10001111 \\ \hline 00101111 \end{array} & \begin{array}{r} 0101011010001 \\ +\ 0111000011000 \\ \hline 1100011010101 \end{array} \end{array}\right)$$

Koma duten hamartarrak bitarrera

0'125 · 2 = 0'25 → alde osoa 0 MSB
0'25 · 2 = 0'5 → alde osoa 0
0'5 · 2 = 1 → alde osoa 1

0,001

0'15 · 2 = 0'3 → alde osoa 0
0'3 · 2 = 0'6 → alde osoa 0
0'6 · 2 = 1'2 → alde osoa 1
0'2 · 2 = 0'4 → alde osoa 0
0'4 · 2 = 0'8 → alde osoa 0
0'8 · 2 = 1'6 → alde osoa 1
0'6 · 2 = 1'2 → alde osoa 1
0'2 · 2 = 0'4 → alde osoa 0
0'4 · 2 = 0'8 → alde osoa 0

$0'00\overline{1001}$

Komadun bitarrak hamartarrera

$11,011 = 1 \cdot 2^1 + 1 \cdot 2^0 + 0 \cdot 2^{-1} + 1 \cdot 2^{-2} + 1 \cdot 2^{-3}$

$2+1, \frac{1}{4} + \frac{1}{8}$

3,375

Booleaan algebra

Trokkerne: $A+B = B+A \qquad A\cdot B = B\cdot A$

Elkarkerne: $A+(B+C) = (A+B)+C$

$A\cdot(B\cdot C) = (A\cdot B)\cdot C$

Baralerne: $A+(B\cdot C) = (A+B)\cdot(A+C)$

$A\cdot(B+C) = (A\cdot B)+(A\cdot C)$

$A+0 = A \qquad A+\bar{A} = 1$

$A\cdot 1 = A \qquad A\cdot\bar{A} = 0$

$A+1 = 1 \qquad \bar{\bar{A}} = A$

$A\cdot\emptyset = \emptyset \qquad A+A\cdot B = A$

$A+A = A \qquad A+\bar{A}\cdot B = A+B$

$A\cdot A = A \qquad (A+B)\cdot(A+C) = A+B\cdot C$

De Morgan

$\overline{X\cdot Y} = \bar{X}+\bar{Y} \qquad \overline{a\cdot b\cdot\ldots\cdot n} = \bar{a}+\bar{b}+\ldots+\bar{n}$

$\overline{X+Y} = \bar{X}\cdot\bar{Y} \qquad \overline{a+b+\ldots+n} = \bar{a}\cdot\bar{b}\cdot\ldots\cdot\bar{n}$

Shanon

$F = A+B \rightarrow \bar{F} = \overline{A+B} = \bar{A}\cdot\bar{B}$

Andeten

$\bar{X}+\bar{Y}+\bar{Z}$

$\bar{X}\cdot\bar{Y}\cdot\bar{Z}$

$X\cdot Y\cdot Z$

$\overline{(A+B+C)}+\bar{D}$

$\overline{A\cdot B\cdot C}\cdot\overline{D\cdot E\cdot F}$

$\overline{A\bar{B}}\cdot\overline{\bar{C}\cdot D} = (\bar{A}+B)\cdot(C+\bar{D})$

Funtzioak kanoniko bihurtu (minterm eran)

$$\underbrace{A\bar{B}C}_{1} + \underbrace{\bar{A}\bar{B}}_{2} + \underbrace{AB\bar{C}D}_{3}$$

$1 \to A\bar{B}C(D+\bar{D}) \to A\bar{B}CD + A\bar{B}C\bar{D}$

$2 \to \bar{A}\bar{B}(C+\bar{C})(D+\bar{D}) \to (\bar{A}\bar{B}C + \bar{A}\bar{B}\bar{C})(D+\bar{D}) \to \bar{A}\bar{B}CD + \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}\bar{C}\bar{D}$

$3 \to AB\bar{C}D$

$$f(A,B,C,D) = \underset{1011}{A\bar{B}CD} + \underset{1010}{A\bar{B}C\bar{D}} + \underset{0011}{\bar{A}\bar{B}CD} + \underset{0010}{\bar{A}\bar{B}C\bar{D}} + \underset{0001}{\bar{A}\bar{B}\bar{C}D} + \underset{0000}{\bar{A}\bar{B}\bar{C}\bar{D}} + \underset{1101}{AB\bar{C}D}$$

$$f(A,B,C,D) = \sum(0,1,2,3,10,11,13)$$

Funtzioa kanoniko bihurtu (maxterm eran)

$$\underbrace{(A\bar{B}+C)}_{1}\underbrace{(\bar{B}+C+\bar{D})}_{2}\cdot\underbrace{(A+\bar{B}+\bar{C}+D)}_{3}$$

$$f(A,B,C,D) = \prod(4,5,13,6)$$

$1 \to A+\bar{B}+C+\overset{0}{D\cdot\bar{D}} = (A+\bar{B}+C+D)(A+\bar{B}+C+\bar{D})$

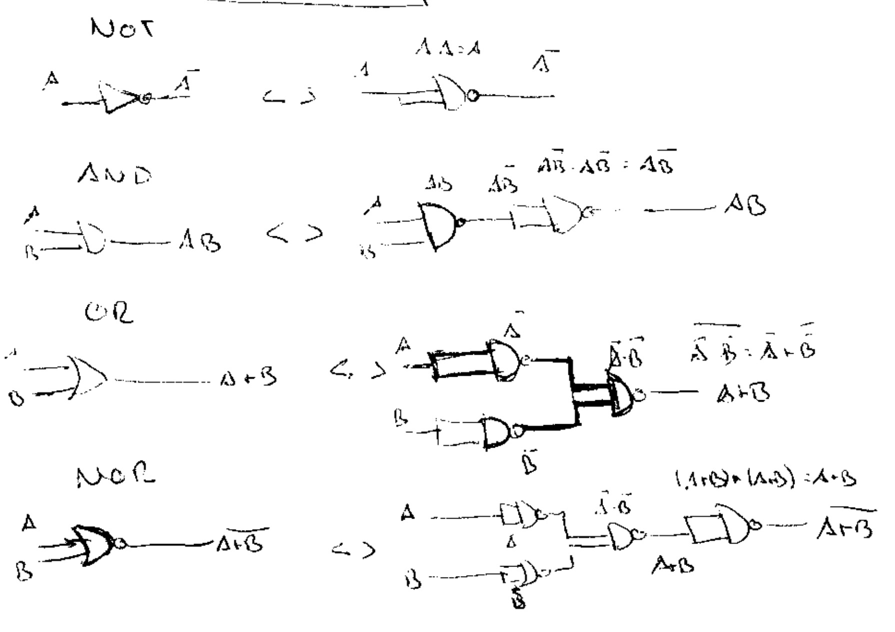
$2 \to \bar{B}+C+\bar{D}+\overset{0}{A\cdot\bar{A}} = (A+\bar{B}+C+\bar{D})\cdot(\bar{A}+\bar{B}+C+\bar{D})$

$$f(A,B,C,D) = \underset{0100}{(A+\bar{B}+C+D)}\underset{0101}{(A+\bar{B}+C+\bar{D})}\underset{0101}{(A+\bar{B}+C+\bar{D})}\underset{1101}{(\bar{A}+\bar{B}+C+\bar{D})}\underset{0110}{(A+\bar{B}+\bar{C}+D)}$$

berdinak dira

NAND eta NOR ateak unibertsalak dira. NAND ateak erabiliz, edo NORekin, OR, AND ateak eta beste lekeregarriekin NOR e.a lor daitezke, eta bigarrenaren bitartez NAND.

$\boxed{\text{NAND ateak erabiliz}}$



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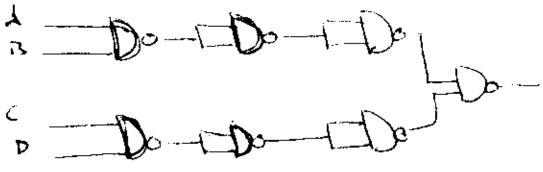
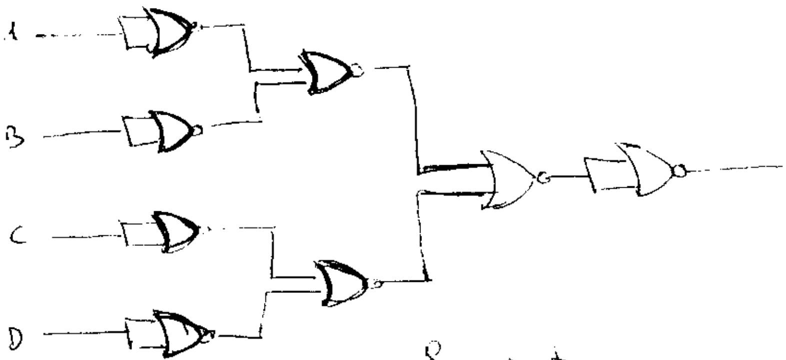
$A \cdot B + C \cdot D$



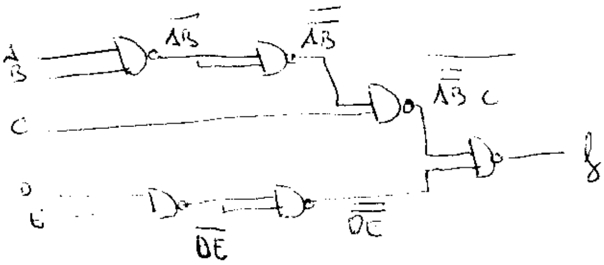
7 nand gate

8 nand gate



8 nor gate

$$f = ABC + \bar{D} + \bar{E} = ABC + \overline{DE} = \overline{\overline{ABC + \overline{DE}}} = \left[\overline{\overline{ABC + \overline{DE}}}\right] = \overline{\overline{ABC}\ \overline{\overline{DE}}} = \overline{\overline{\overline{ABC}}} \cdot \overline{\overline{DE}} = f$$



Karnaughen napa

$$f = \bar{A}\cdot\bar{B}\cdot\bar{C} + \bar{A}\bar{B}C + AB\bar{C} + A\bar{B}\bar{C}$$

000   001   110   100

minterm $\bar{A} \to 0$, $A \to 1$

AB \ C	0	1
00	1	1
01		
11	1	
10	1	

! [illegible] [illegible] [illegible] [illegible] [illegible] gelir jeye göre [illegible] bakım [illegible].

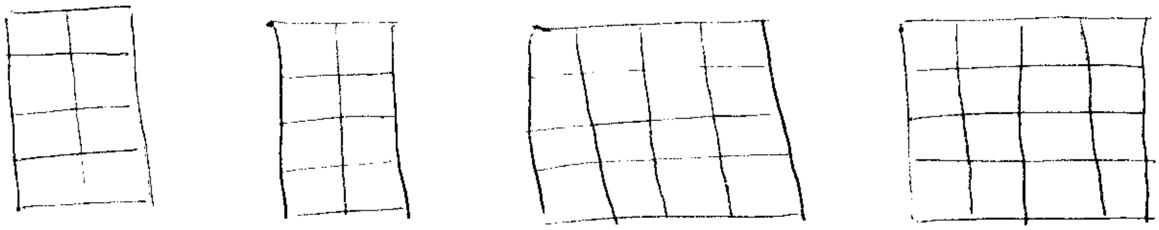
! [illegible] [illegible] [illegible] [illegible] [illegible] göre [illegible] ayrıca den [illegible] [illegible] [illegible], [illegible] [illegible], minterm [illegible], 1 [illegible]. [illegible] [illegible]. 0 [illegible] [illegible].

Multzoen balio aldakorretik ez duen aldagaia jasotzen da. Marrak edo ezeztatutakoa gehituko dioen naturalezaren balioaren arabera eta erabiltzen ari garen sistema gorritzor (minterm / maxterm).

$f(A,B,C) = \bar{A}\bar{C} + AC + \bar{B}$

$f(A,B,C,D) = A\bar{B}D + \bar{A}B + \bar{A}\bar{C}$

$f(A,B,C,D) = \bar{D} + \bar{C}B$



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5 aldagai izanda, aldagai bat kanpoko dago eta bi taula erabiliko. Lehenengoan 0 beraila kanpoko dago kanpotakoa eta bigarrenean 1 balioa esleituko diogu. Adibidez: $f(A,B,C,D,E)$

AB \ CD	00	01	11	10
00				1
01		1	1	1
11	1	1		1
10	1	1		1

E = 0

AB \ CD	00	01	11	10
00				1
01		1	1	1
11				1
10		1		1

E = 1

! Posizio beraren dauden zeldak ondoko ondokoak dirateke.

$f(A,B,C,D,E) = A\bar{C}\bar{E} + \bar{A}BD + C\bar{D} + A\bar{B}\bar{C}D$

AB \ CD	00	01	11	10
00	1			1
01				
11			1	1
10	1			

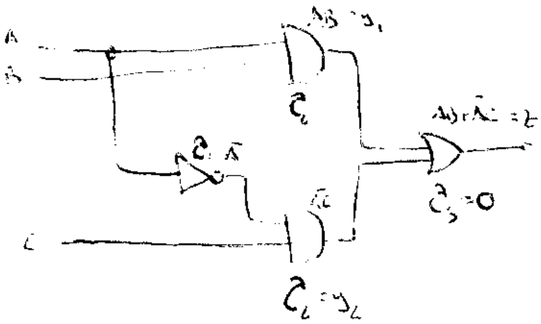
E = 0

AB \ CD	00	01	11	10
00		1	1	
01		1	1	
11			1	1
10	1			

E = 1

$f(A,B,C,D) = \cancel{\bar{A}\bar{B}\bar{C}\bar{D}\bar{E} + \bar{A}\bar{B}\bar{C}\bar{D}E + \bar{A}DE + ABC + A\bar{B}\bar{C}\bar{D}}$

$= \bar{A}\bar{B}\bar{D}\bar{E} + \bar{A}DE + ABC + A\bar{B}\bar{C}\bar{D}$

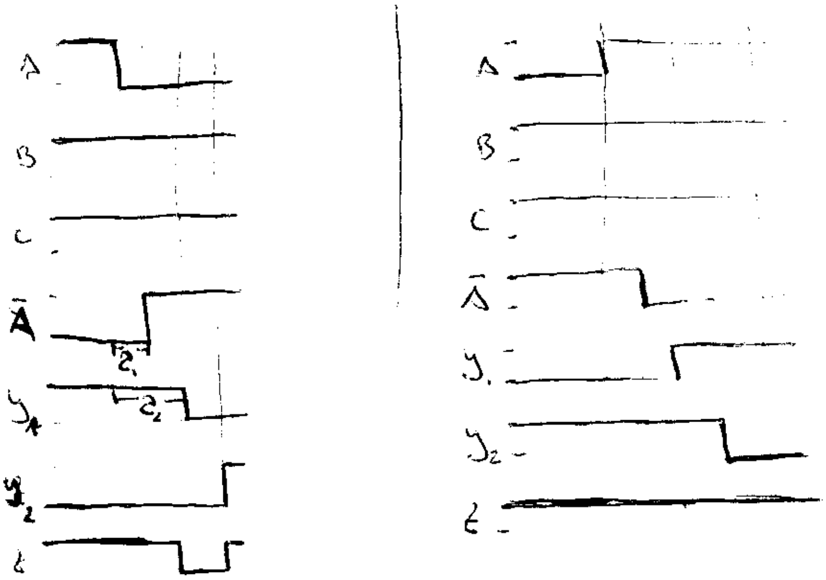


$\tau_2 > \tau_1$

A B \ C	0	1
0 0		1
0 1		1
1 1	1	1
1 0		

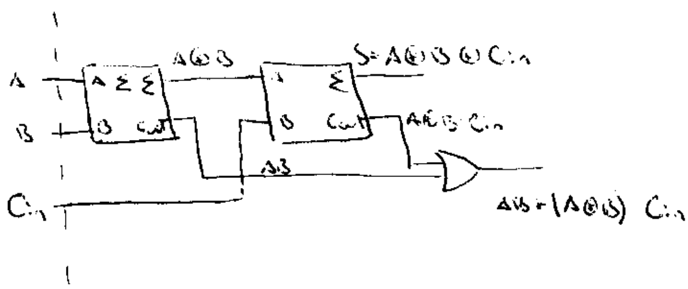
$AB C + AB\bar{C} + \bar{A}BC + \bar{A}\bar{B}C$
111 110 011 001

$\sum(1,3,6,7)$



Kombinatoriek → gewoon problemen gaten oplossen en schema bekomen
Sekwentiële → ordenen. Process → [illegible] [illegible] [illegible] [illegible] [illegible]

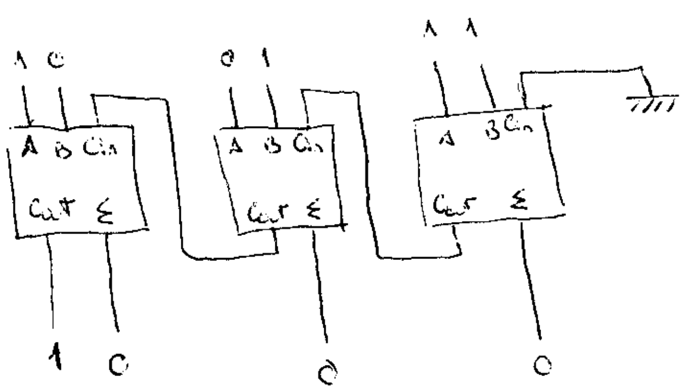
Niet eigen bitstromen [illegible] [illegible] abstracties:



$$C_{i+1} = a_i b_i + c_i (a_i \oplus b_i)$$
$$= a_i b_i + c_i (a_i + b_i)$$

Ripple-carry adder

Add: A: 101
B: 011



$$\begin{array}{r} 101 \\ +\ 011 \\ \hline 1000 \end{array}$$

ED-II-018 [redacted]

BCD - 7 segmentu

Zeroen ezabapena: beharrezkoak ez diren 0ak kentzeko erabiltzen da digito bat baino gehiagoko displayetan.

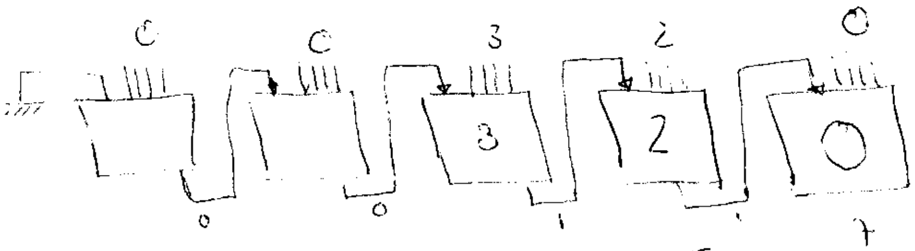
Aurretiko ezabapena: ~~0~~ ~~0~~ 6

Atzetiko ezabapena: 6.5 ~~0~~ ~~0~~

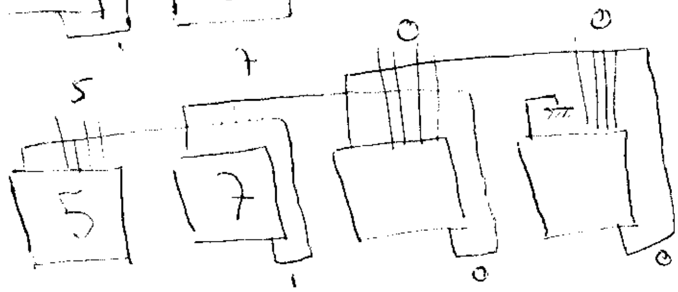
Segun nola konektatzen dugun Rbi, aurretiko edo atzetiko ezabapena display batetik bestera hedatuko da.

$\overline{Bi}$ → Blanking input

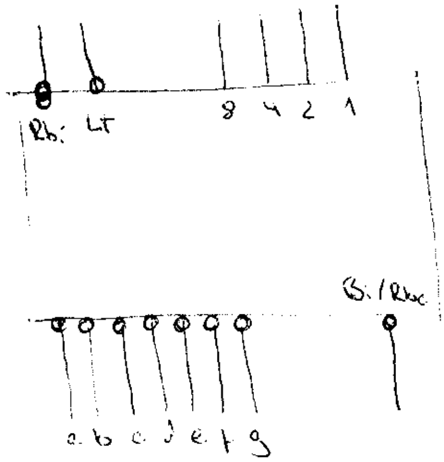
$\overline{Rbo}$ → Ripple blanking output



Aurretiko ezabapena



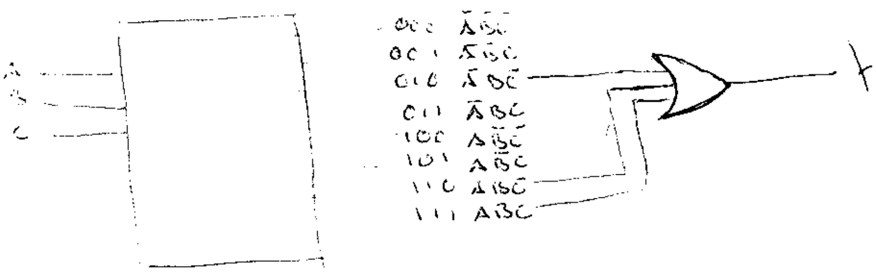
Atzetiko ezabapena

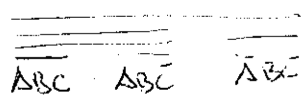


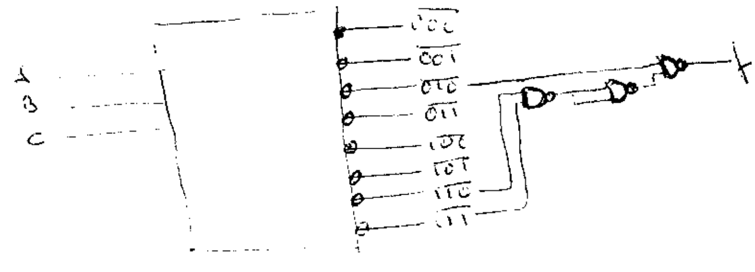
Dekodegailuak erabiliz, funtzio logikak garatu

$f = A\bar{B}C + AB\bar{C} + \bar{A}B\bar{C}$

Nola garatu dezakegu aurreko funtzioa ~~Bi~~ ~~8~~ Bi eta 2-NAND atekapuro bakarrik erabiliz?







*Prioritatekoetan sarrera bat baino gehiago aktibatu daitekeen kasuan gisa ~~[illegible]~~ handienakoa aukeratuko da.

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Bihurgailuak (bitar - BCD)

18	0001 1000$_{BCD}$	
	00010010$_2$	
25	0010 0101$_{BCD}$	
	00011001$_2$	

[0, 9] → berdin
[10, 15] → +6
[16, 19] → +6
[20, 29] → +12

0 - 9 → berdin
10 - 19 → +6
20 - 29 → +12
30 - 39 → +18
40 - 49 → +24
50 - 59 → +30
...

Hamming kodea

$P_1 = D_3 \oplus D_5 \oplus D_7$

$P_2 = D_3 \oplus D_6 \oplus D_7$

$P_4 = D_5 \oplus D_6 \oplus D_7$

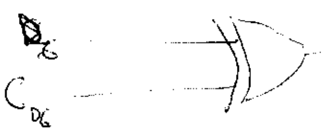
XOR
"1" kopuru bikoitia → 0
"1" kopuru bakoitia → 1

D_3	D_5	D_7	P_1	C_1
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	0
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	0

Paritatearen bitak beraiekin batera ere gehitzen, "1" kopurua bikoitia izango da guztietan.

C_4	C_2	C_1	
0	0	0	0 Ez dago akatsik errorea
0	0	1	~~1 akatsa 1 posizioan~~
0	1	0	~~2 akatsa 2 posizioan~~
0	1	1	3 akatsa 3 posizioan
1	0	0	~~4 akatsa 4 posizioan~~ — ondo sinbolikoak dira
1	0	1	5 akatsa 5 posizioan
1	1	0	6 akatsa 6 posizioan
1	1	1	7 akatsa 7 posizioan

! Akatsa informazioaren bit bateko bakarrean egoteko dugun aldaera onartutako dago.



D_6	C_{D6}	D_{1C}
0	0	0
0	1	1
1	0	1
1	1	0

Baldin $C_{D6} = 0$, ez dago akatsik, D_6 berdina.

Baldin $C_{D6} = 1$, akatsa dago, D_6 aldatu.